

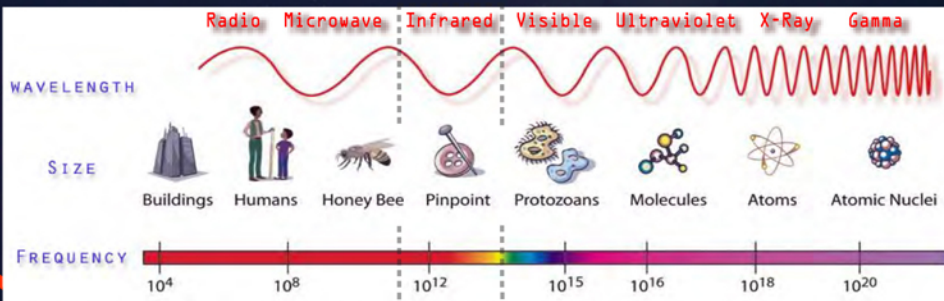


NASA's Lunar Laser Communication Demonstration



Lunar Laser Communication Demonstration

NASA is changing the way its satellites send their data back to Earth and how they communicate with astronauts in space, starting with the Lunar Laser Communication Demonstration (LLCD) mission. LLCD will demonstrate the future of communicating in space with the use of laser beams for data transmissions instead of radio waves. Radio wave communications have proved reliable over the past few decades, but may not meet all the needs of future science and human exploration missions. NASA devised the solution of using near-infrared light waves, generated by lasers, to communicate larger volumes of data from space with the added benefit of allowing for smaller, lightweight and lower-power transmitters. The LLCD mission will fly a laser communication terminal to lunar orbit as a payload aboard the Lunar Atmosphere Dust Environment Explorer (LADEE) spacecraft while employing a robust ground segment of three optical ground terminals in cloud-free locations around the globe. The entire system will be demonstrated over the course of a month while LADEE orbits the Moon. Each ground site will thus see operations during the day, during the night, high in the sky, and low in the sky as the month progresses. LLCD will demonstrate sending HD video and other scientific data between Earth and the Moon and, if successful, will validate a new way of communicating in space.



Electromagnetic Spectrum

When you tune your radio, watch TV, send a text message, or pop popcorn in a microwave oven, you are using Electromagnetic (EM) energy. EM energy travels in waves and spans a broad range of wavelengths known as the EM Spectrum. Radio waves have the longest wavelengths while gamma-rays have the shortest, and infrared light waves fall in between. Radio waves are used to transmit music across the radio and for virtually all satellite communications. X-rays are so short in wavelength that they pass right through you so that doctors can use them to take pictures of human bones. NASA's scientific instruments use the full range of the electromagnetic spectrum to study the Earth, the solar system, and the universe beyond.

Space Terminal

The Lunar Lasercomm Space Terminal (LLST) aboard LADEE has three components: the Optical Module (OM), the Modem Module (MM), and the Controller Electronics (CE). The OM is a 10-cm (4") diameter telescope on a two-axis gimbal which will constantly keep the LLST pointed to the ground receiver while LADEE orbits the moon. The MM contains the 0.5 watt near-infrared laser transmitter that is connected to the OM telescope by an optical fiber. The MM also contains the optical receiver that deciphers the pulses of light sent up from the ground terminal and turns them into data. The CE, located inside the LADEE spacecraft, is the brain of the LLST, which provides control, pointing, acquisition, and tracking functions for the OM and MM. All three modules weigh 30.7 kg (63 lbs) in total and require 90 watts during operations.



Data beamed down from the LLST will be collected and analyzed by the Lunar

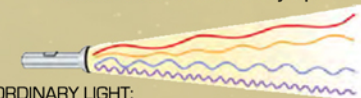
Lasercomm Ground Terminal (LLGT) in White Sands, NM. The LLGT consists of eight telescopes. Four 15-cm (6") telescopes will locate the LLST using an acquisition beam; these telescopes will also transmit commands and data to the LLST at up to 20 Mbps. Four 40-cm (17") receiving telescopes will collect and focus the faint downlink signals from the LLST at the Moon into optical fibers and then on to sensitive detectors in the control room. The LLST can also communicate to two additional ground terminals in California and Spain.

Ground Terminal

Laser Communications

Lasers are a special form of light that does not exist in nature and can only be created using human technology. Laser light is different from "ordinary" or natural light because:

1. It contains exactly one color, or wavelength, of light.
2. Laser light is coherent, meaning that all of the waves are oscillating "up-and-down" together.
3. While light waves from ordinary sources like flashlights or the Sun spread out in all directions, laser light waves can be made to travel in the same direction and can be concentrated on one tiny spot.



ORDINARY LIGHT:
Many wavelengths, Multiple colors, Incoherent waves



LASER LIGHT:
One wavelength, One color, Coherent waves

All of these attributes make lasers a great tool for communications!

The lasers that LLCD will use generate near-infrared waves, which have shorter wavelengths than radio waves. This shorter wavelength means that more data can be packed onto each laser beam! Also, laser light spreads out about 10,000 times less than radio waves, so LLCD will be able to send data directly to the ground terminals without it being received elsewhere as well. LLCD is NASA's first mission to perform laser communication both to and from the Moon and will do so by sending hundreds of millions of these infrared laser pulses back to Earth every second!

Connect with LLCD!

For more info on the LLCD mission

please visit our website:

LLCD.gsfc.nasa.gov

or follow us on Twitter:

@NASALasercomm



Downloading an HD movie from the Moon at current radio transmission rates would take over an hour...

60+ minutes



...while at **622** megabits per second, LLCD can download that same HD video in under **8 minutes!**

Developed in 1960, the term LASER is an acronym:

Light
Amplification by
Stimulated
Emission of
Radiation